

Creating Digital Libraries for Flight Projects

**Presented at the Society of American Archivists Conference
Orlando, Florida
September 5, 1998**

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Introduction

During the last decade, the amount of digital information available for searching, retrieving, manipulating, and modeling has exploded. Desktop tools, improvements in network connectivity and bandwidth, and interoperability across systems has led to an information proliferation. Our expectation of faster information delivery increases exponentially with the amount of information enabled by new information technologies. The abundance of on-line information has raised serious questions for the archival profession about the quality, usability, and long-term preservation of digital information.

Jet Propulsion Laboratory (JPL) is typical of many large institutions where the rate of information creation has challenged its ability to manage intellectual assets at an institutional level. We also have a deeply rooted culture that has allowed flight projects the autonomy to develop their own processes and tools to create, manage, and distribute information. Some projects have designed information systems to store and manage information for internal project use and have allowed non-project staff access only on a limited basis. In addition, these project-specific repositories have not always addressed information life cycle issues of long-term preservation and access because projects are primarily interested in their project information while the project is active, not post-project. This paper will discuss the design and implementation of digital flight project libraries and how the information life cycle processes (from creation to preservation) not only provided the framework for the design, but a shared model for communication and collaboration among a multi-disciplinary development team.

Early Project Library Efforts

The design and implementation of digital libraries based on flight project information life cycle processes, emerged programmatically within a JPL initiative called "Develop New Products" (DNP): a re-engineering effort to create "faster, better, cheaper" planetary missions. A key component in designing quick, low-cost missions is leveraging the good ideas and practices from previous missions. Information sharing and re-use is an important tenant of the DNP process and a guiding principle in the development of digital libraries.

Before DNP, most projects used unique, independent information management systems which limited access to project members. This benefited individual projects, but made it difficult for non-project staff to find information they needed. What developed were people information networks: if you knew the right people you could get the information you needed. Characteristics of people information networks is they can be exclusive and inefficient; it takes time and effort to match the information keepers with the information needed.

Local development of information systems can be traced to the Lab's early projects of more than forty years ago, well before electronic information capture technology. Physical repositories of

information, often referred to as “project libraries”, were put in place for each flight project. Generally these repositories were administered by project secretaries or administrative staff and were physically located near project staff. The evolution of project libraries changed very little until the use of information technology in the late 1970s [figure 1.].

Evolution of Project Libraries

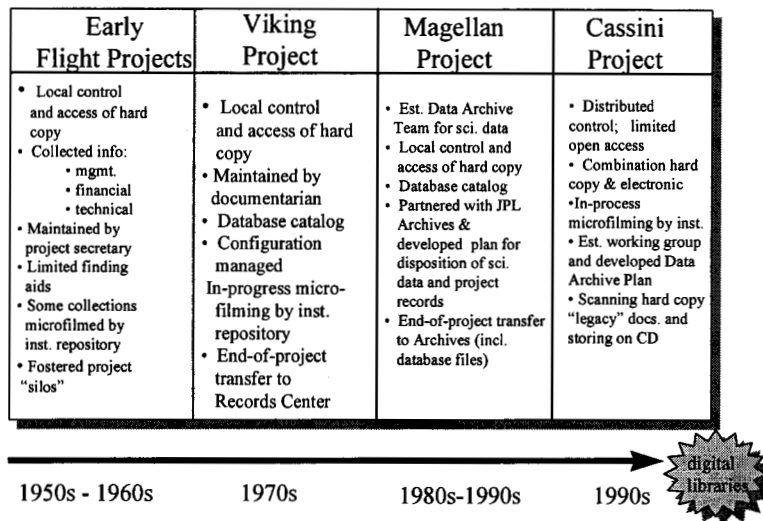


Figure 1.

Digital Library Development

There are numerous definitions for “digital libraries” and they continue to change as the information technology matures. The National Science Foundation sponsored a workshop on distributed knowledge work environments in the spring of 1997 from which a definition on digital libraries emerged, which is very consistent with the interpretation of digital libraries in the JPL context:

... the concept of a ‘digital library’ is not merely equivalent to a digitized collection with information management tools. It is rather an environment to bring together collections, services, and people in support of the full life cycle of creation, dissemination, use, and preservation of data, information, and knowledge. ¹

At JPL, we began the design of the digital libraries with this notion that it was more than a tool, but a system based on a process, technology and service base that complements how a project creates, manages, and uses information. The digital library team consisted of engineers, information technology professionals, archivists, librarians, and project staff. The primary goal of the team was to demonstrate that a process for digital library design, implementation, and operations could be developed to support project information management and institutional records management requirements. If successful, the team realized that digital libraries could replace JPL’s information silos with accessible, distributed on-line repositories.

Working with a diverse team allowed us to develop a process and system that addressed a spectrum of user and institutional needs, but convergence on a single approach required understanding the differing perspectives of the team members. Some members were more focused on how to build the tool, rather than looking at what information needed to be captured and managed, and how it would be used and reused. As the archivist on the team, I was concerned about long-range issues, such as capturing obsolete or historical versions of information, migrating data across multiple generations of hardware and software, and what standards and policies to adopt to ensure preservation and accessibility of digital information. An interesting, and quite surprising revelation during the requirements definition phase of this work was learning that my views on capturing information for primary and secondary uses, was not that dissimilar than the engineer's perspective on our team. What I did learn, however, is that secondary use or what is referred to commonly at JPL as "re-use" can have very different meanings. To be able to re-use information, in an engineering context, requires that the data have functionality. It is not enough to merely capture information in a web-viewable format like HTML or PDF, when users require that the data can be manipulated. Retaining the original native application file in digital libraries became critical success factor if the libraries were to be used and supported by technical staff.

During the requirements development phase, we also kept abreast of the activities of professional library and archives working groups who were discussing the operational definitions of digital libraries. Improvements in commercial tools for scanning and capturing digital information, and library and archival cataloging systems for managing metadata, did not go unnoticed, but we found few products that could be tailored to manage flight project data. Although the commercial technology at the time did not satisfy our requirements, evaluating commercial products was helpful in developing a digital library design modeled on the information life cycle process. [figure 2]

Information Life Cycle Process

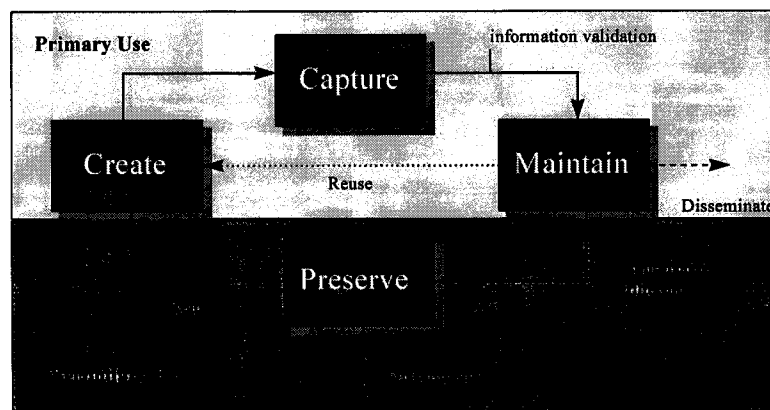


Figure 2.

The digital library process and design concept evolved from a numerous working sessions with the team and various end-users. Wary of over-designing the system, the team agreed to a straight-forward set of criteria which included:

- web-based interface with add, browse, search, and retrieve
- user ability to upload native and web-viewable files
- multi-platform: PC, Machintosh, UNIX
- multi-media: text and images
- search: fielded, string, and keyword
- data access control for sensitive files
- industry and JPL standard data formats (MS Office suite, PDF, HTML, JPEG, GIF, TIFF, ASCII)
- standard metadata used across all digital project libraries
- in-process archival appraisal
- ability to migrate metadata and files to other database systems
- easy, cost effective tailoring, set-up, and operations

Mars Pathfinder was selected as the pilot for the first digital library because it had all of the right components: a well defined collection of project documents and information, many in electronic format; a dedicated project librarian; and a willingness to be the testbed for rapid prototyping and proof-of-concept of the digital library process and design. After several months of development and testing, the initial Mars Pathfinder digital library was completed and rolled out to project staff. The library consisted of a web interface to a database that allowed the librarian to add, edit, and delete metadata and electronic files, as well as archive obsolete or historical files. Users could search, browse, retrieve and download electronic files.

The experience gained from the working on a multi-disciplinary team and partnering with the Mars Pathfinder Project enabled us to meet our goals of creating a process, technology and service base for the easy instantiation of digital libraries and at a reasonable cost to projects. [fig. 3] In the two years since this task began, the team has implemented twenty digital libraries. Although the Laboratory has yet to decide on a single design for project information management systems, the digital library has eliminated a number of information silos, by making project documents and data accessible to all JPL employees.

Project Library Process

Developed a process for project library design, setup, implementation, training, and operations support

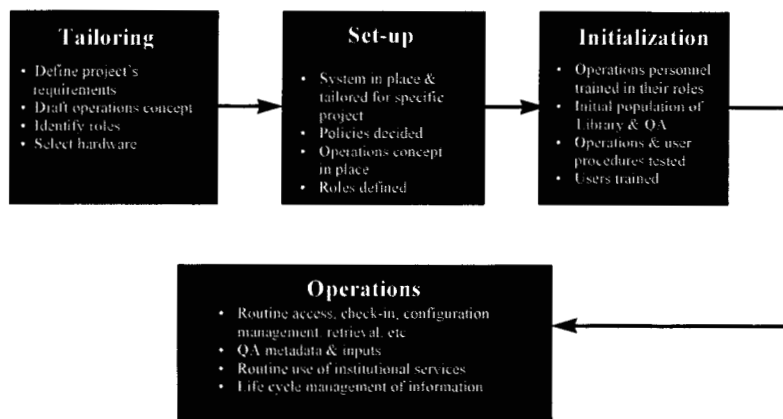


Figure 3.

Lessons Learned and Future Developments

While the team was designing and developing the digital library, we conducted in-process lessons learned by collecting and analyzing performance metrics and user feedback from pilots and operational libraries. Several outstanding lessons emerged. First, create a diverse team that represents end-users, information technologists, engineers, and information specialists – archivists and librarians. Although the work took place in a research and development atmosphere, the design evolved with the input of the major stakeholders and resulted in a useful product. Second, develop a process on which to model the architecture. It was obvious to the team that the process to guide our work was the information life cycle. This tool would only be used by projects if it was modeled on their information creation, use, and re-use processes. Third, keep the design simple and the interface intuitive for users. Although our team had many ideas for fuller functionality, such as automating operations features, we intentionally retained manual processes to insure the quality of the metadata and files. Finally, life cycle management of digital documents requires that an archivist or information professional become involved with documents as early on in the information life cycle process. Developing the capability in the digital library for in-process archival appraisal has greatly improved the Laboratory's ability to identify, collect, and preserve its electronic records.

One of the most gratifying aspects of the digital library task has been working with the Mars Pathfinder Project Library collection throughout its life cycle. During the course of the Pathfinder Project other Laboratory projects were turning the digital library to find information that would be helpful to their projects. Documents captured in the library, such as plans, reports, spacecraft design files, science team minutes, and outreach information, are continuously requested. The information life cycle process has now entered the final stage on the Pathfinder Project, where the archiving of historically significant data begins. Part of the project closure process is to migrate the digital library data to an electronic archive. Because JPL has not yet developed an institutional electronic archive capability, we are literally pathfinding our way. The collection of

Mars Pathfinder documents as been appraised and archive selections made, and we are now collaborating with JPL's Planetary Data System--the work unit responsible for archiving planetary image data--to create an electronic archive for project documents.

Inherent with digital technology are a wide range of issues about the longevity of digital archive media, the ability to read hardware and software dependent formats over time, and the amount of functionality needed in an archival electronic record to ensure its usability. There are many trade-offs, including what needs to be retained for information purposes to meet institutional requirements for records retention versus how to manage native file formats so they are still usable years from now. We have only to look at obsolete file formats like WordStar to understand the vulnerability of software-dependent data and find solutions to the problems of format obsolescence.

While digital libraries have been very successful across numerous JPL flight projects, in the next year our efforts will be focused on creating an institutional information architecture for JPL's distributed information environment. The architecture will be based on interoperability among tools, use of standard metadata and transmission protocols to enable capture, management, dissemination, and preservation of the content and context of the Laboratory's intellectual assets. To do this we will be following the research in digital technology preservation being done by the Getty Conservation and Information Institutes, RAND Corporation, and the JPL Planetary Data System, which are examining significant issues concerning software and hardware obsolescence, and options for migrating and refreshing data to keep pace with evolving technology. In addition we are interested in collaborative development efforts such as of the Digital Libraries Initiative, sponsored by NSF/DARPA/NASA, and evaluating the feasibility of adopting structured metadata as advocated by the Dublin Core and encoded archival description projects. There is no easy solution for ensuring the longevity and usefulness of digital information. The digital library work at JPL is a forward-looking approach to capturing and managing information, in ways that satisfy project and institutional record keeping requirements. There is no doubt that the growth in the corpus of JPL electronic records has encouraged JPL to begin allocating resources to preserve the legacy of its flight projects. The digital information frontier, with all of its rapid and often fleeting technological manifestations, is being vigorously explored, directed, and leveraged by the digital library team to ensure that JPL's significant body of knowledge will be preserved.

¹ Paul Duguid "Report of the Santa Fe Planning Workshop on Distributed Knowledge Work Environments: Digital Libraries." [<http://www.si.umich.edu/SantaFe>] Report version, September 20, 1997.

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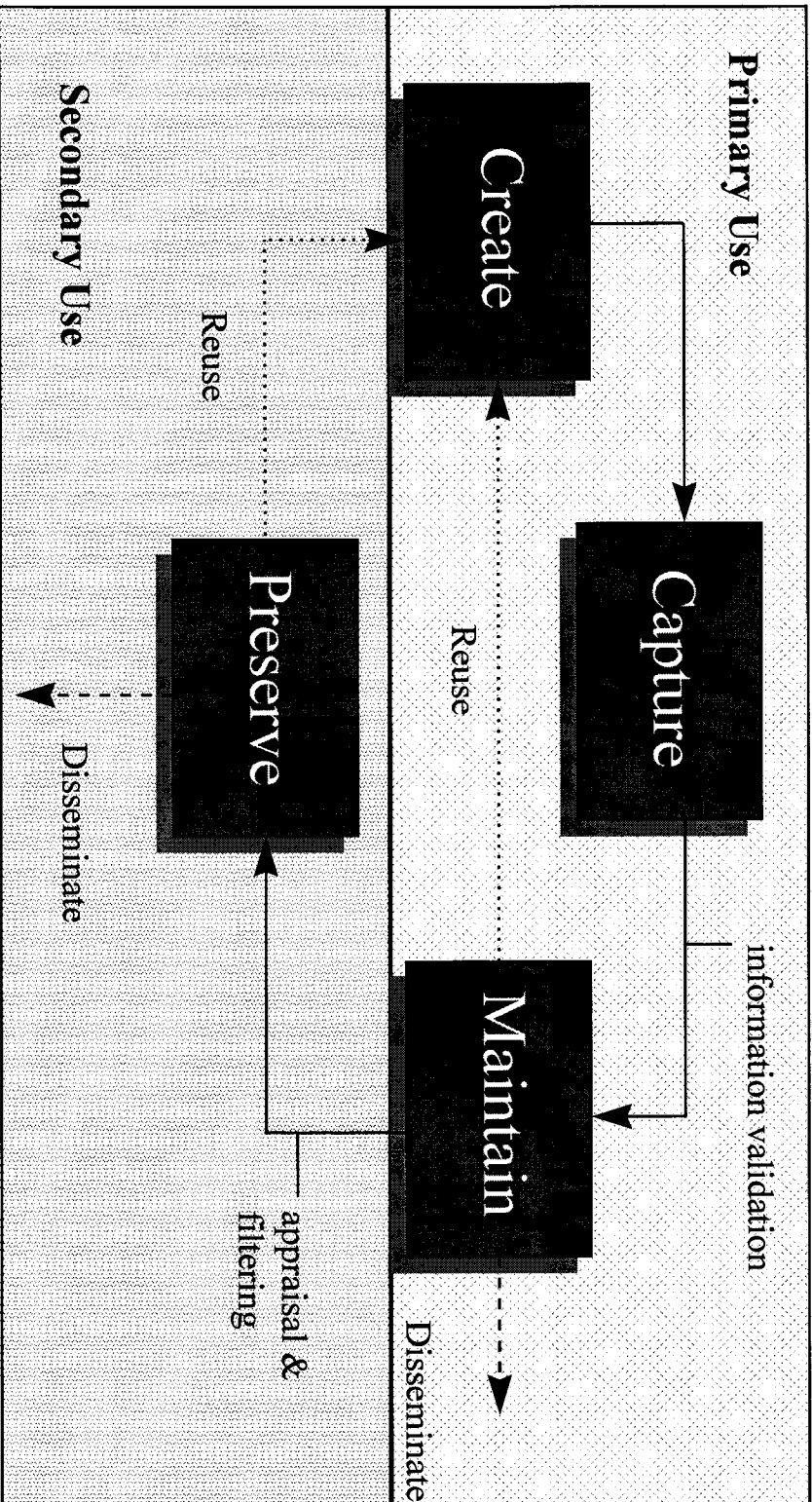
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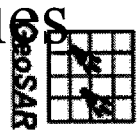
Introduction

- ◆ Project Library evolution: hard copy to digital
- ◆ Design and implementation of digital libraries by multi-disciplinary team
- ◆ Information life cycle issues
- ◆ Next steps and research questions

Flight Project Digital Libraries

Information Life Cycle Process





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Flight Project Digital Libraries

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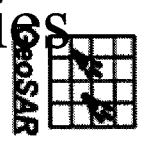
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- 12 - [Critical Design Reviews \(CDR\)](#)
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